SOUTHWEST RESEARCH INSTITUTE

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MEMORANDUM

December 1, 1993

TO: Bill Johnson, NASA Wallops Space Flight Center

FROM: Jim Sharber and John Scherrer

SUBJECT: Interim Status Report, Contract NAG5-671 (SwRI Project 15-3822)

INTRODUCTION

PULSAUR II is a sounding rocket experiment to investigate the pulsating aurora and related phenomena. The payload consists of a complementary set of instruments designed specifically to look at the pulsating aurora. The project will be managed by the Norwegian Space Center, with integration in Norway. The rocket is due for launch in January 1994 from the Andoya rocket range. Southwest Research Institute has been funded by Grant NAG5-671 to provide an electron sensor for this campaign. It is a "top-hat" electron spectrometer, referred to as AREA (Angle Resolving Energy Analyzer), and is based on the electron sensor developed for the CENTAUR mission.

ACCOMPLISHMENTS

Fabrication

Since the last report, final fabrication and assembly tasks were completed. This included conformal coating of all printed circuit boards, staking of all loose components and screws and final programming of the instrument. Figures 1 through 4 are photos of the completed packages. Figure 5 is a detailed photo showing the inside of the power supply box which provides regulated low voltage, microchannel plate bias voltage and the deflection plate sweep voltage.

After the mechanical parts of the sensor were machined, they were then coated with chem film and Aerodag. These parts, which included the inner and outer deflection plate, repelling grid, "top-hat" plate and miscellaneous stand-offs were sent to England for integration to the remaining sensor parts.

Correlator Checkout

A representative from the University of Sussex came to SwRI to support the integration and check-out of the correlator electronics. After approximately two weeks of debugging, the total system was working satisfactorily. The correlator electronics were then conformal coated and staked. Figure 6 is a photo of the correlator electronics.

Sensor Checkout at MSSL

While the correlator was being tested here at SwRI, the sensor was being put through preliminary high voltage tests, noise tests and first order calibration at MSSL in England. Figure 7 and 8 are photos of the AREA sensor. During these preliminary noise checks, it was determined that there was a higher-than-expected background noise.

Sensor Checkout at SwRI

The bulk of the effort during this time period was spent trying to reduce the background count rate. This included replacement of the amplifier threshold resistors to decrease the instruments sensitivity, increasing the gap between high voltage areas, smoothing all sharp corners and points, and applying thick conformal coating to high voltage areas. This effort lowered the noise to a level which we could tolerate (see next section).

Checkout of the AREA instrument was performed at several levels: sensor only, one channel of the sensor with flight electronics with and without flight power supply, and full-up end-to-end system check with all flight electronics using the ground support equipment.

Calibration

The PULSAUR instrument calibration consisted of making detailed measurements of energy and angular resolution for a representative set of anodes, i.e. four anodes, located approximately 90° apart on the circular anode pattern. In addition, in order to determine the relative throughput factor of each of the 24 anodes, relative responses from each channel were measured. This was done by peaking the count in each channel in energy, theta, and phi for a given potential difference between the top-hat plates and recording the values. (Theta and phi are calibration reference angles and correspond to elevation and orthogonal-to-elevation angles on the rocket.)

The calibration measurements yielded results that compared very favorably with the simulation results of the MSSL group. The value of energy resolution for an energy angle scan run was typically 26% with very little variation at the four anodes measured. The deflection sensitivity (deflection constant) was typically 6.0 eV/V. The curves for the Anode 23 measurements are shown in Figure 9, which shows the three standard values of energy resolution (Δ E/E) and deflection sensitivity.

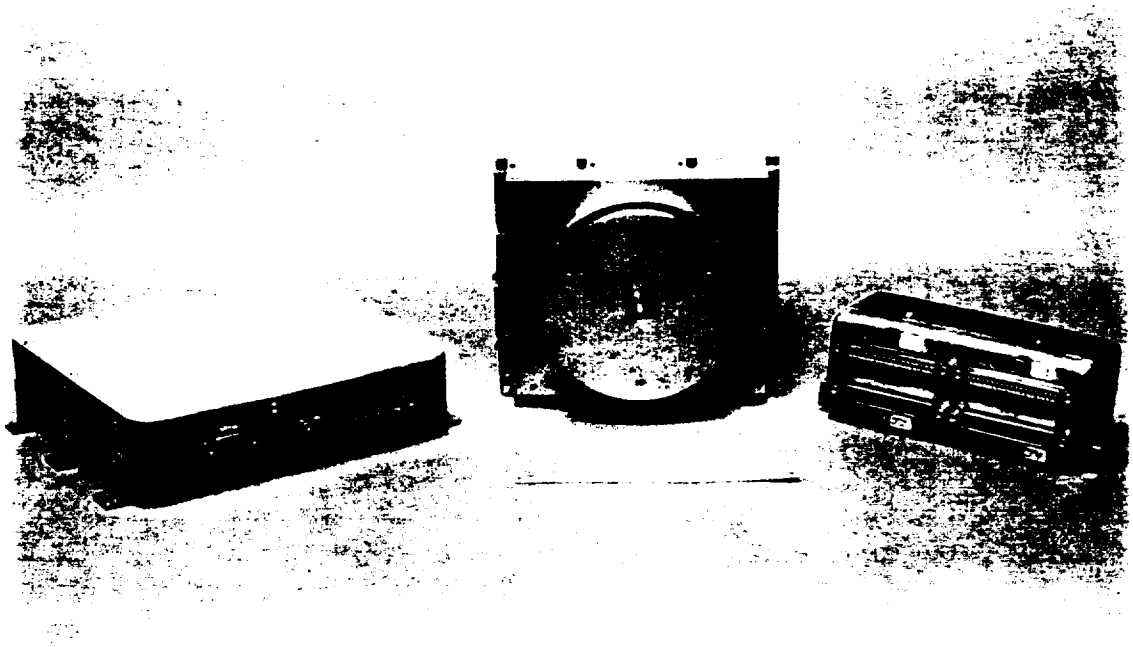
An angular response measurement (phi) of this same anode (Figure 10) shows a value of 10.6° at the FWHM and a value of 18.0° at the 10% points. The angular response perpendicular to that one (theta) is determined primarily by the sector size of the anode, and is slightly less than 15°. This was confirmed by direct measurement as the instrument was rotated about its central axis.

Many anodes contained noise in excess of our expectations with noise levels between 30 and 2000 counts/sec. (The latter value is an extreme case, but most values were in the low hundreds. Also note that the count/sec is to be divided by 200 to obtain the count/accumulation period in the experiment.) Noise counts were recorded for all anodes at deflection voltages of 0, 1000, 2000, and 3000 V in order to be able to produce a "noise mask" for data analysis.

Integration at Norway

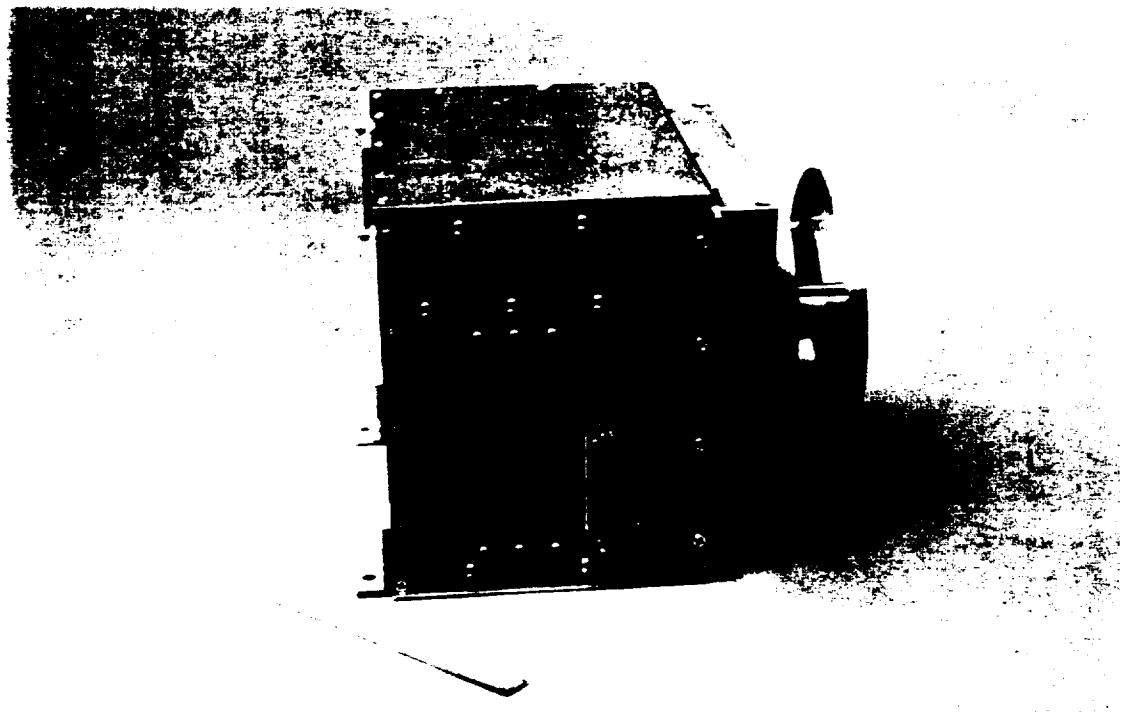
Following calibration, the instrument was sent to Norway for integration on to the sounding rocket. During integration, it was determined that in order for the AREA data stream to match the Norwegian telemetry stream, we were required to invert the AREA data and shift it by one half a clock pulse. The instrument was then sent back to SwRI for this purpose. After approximately two weeks, it was sent back to Norway where integration was successfully accomplished.

We are now awaiting launch in January of 1994.



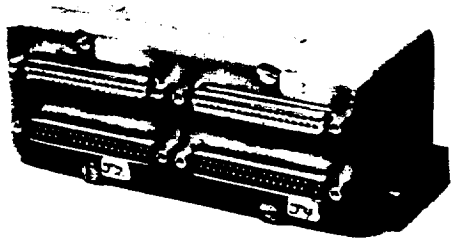
AREA POWER UNIT, SENSOR PACKAGE, AND JUNCTION BOX

Figure 1



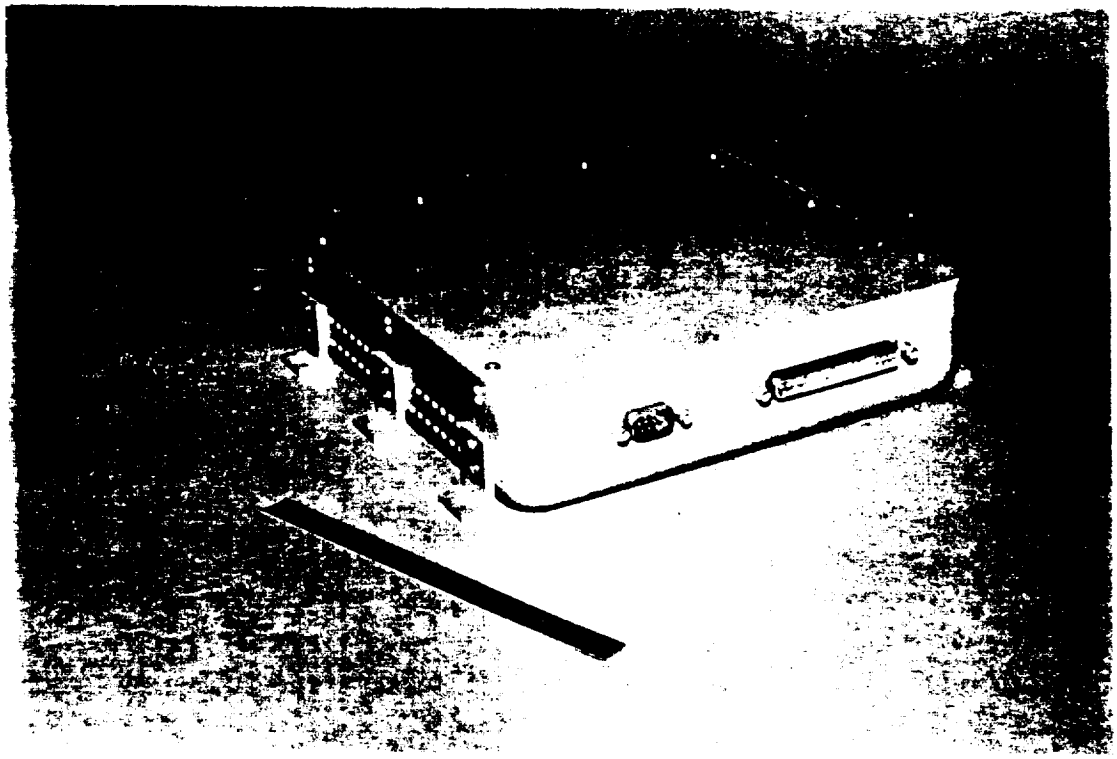
AREA SENSOR PACKAGE, CONTAINING DEFLECTION PLATES AND DIGITAL ELECTRONICS

Figure 2



JUNCTION BOX

Figure 3



POWER UNIT

Figure 4

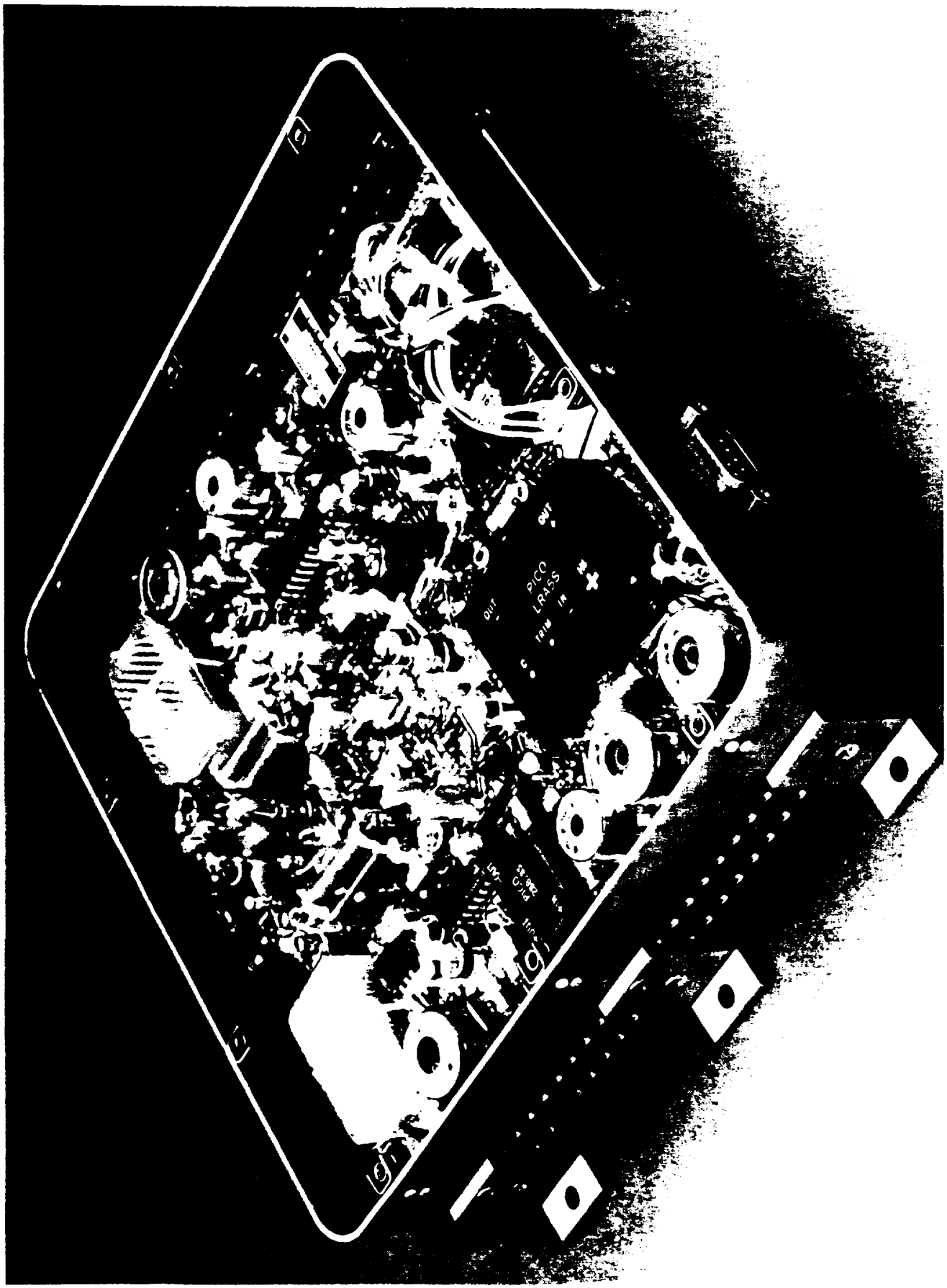


Figure 5. Pulsaur AREA
Power Supply

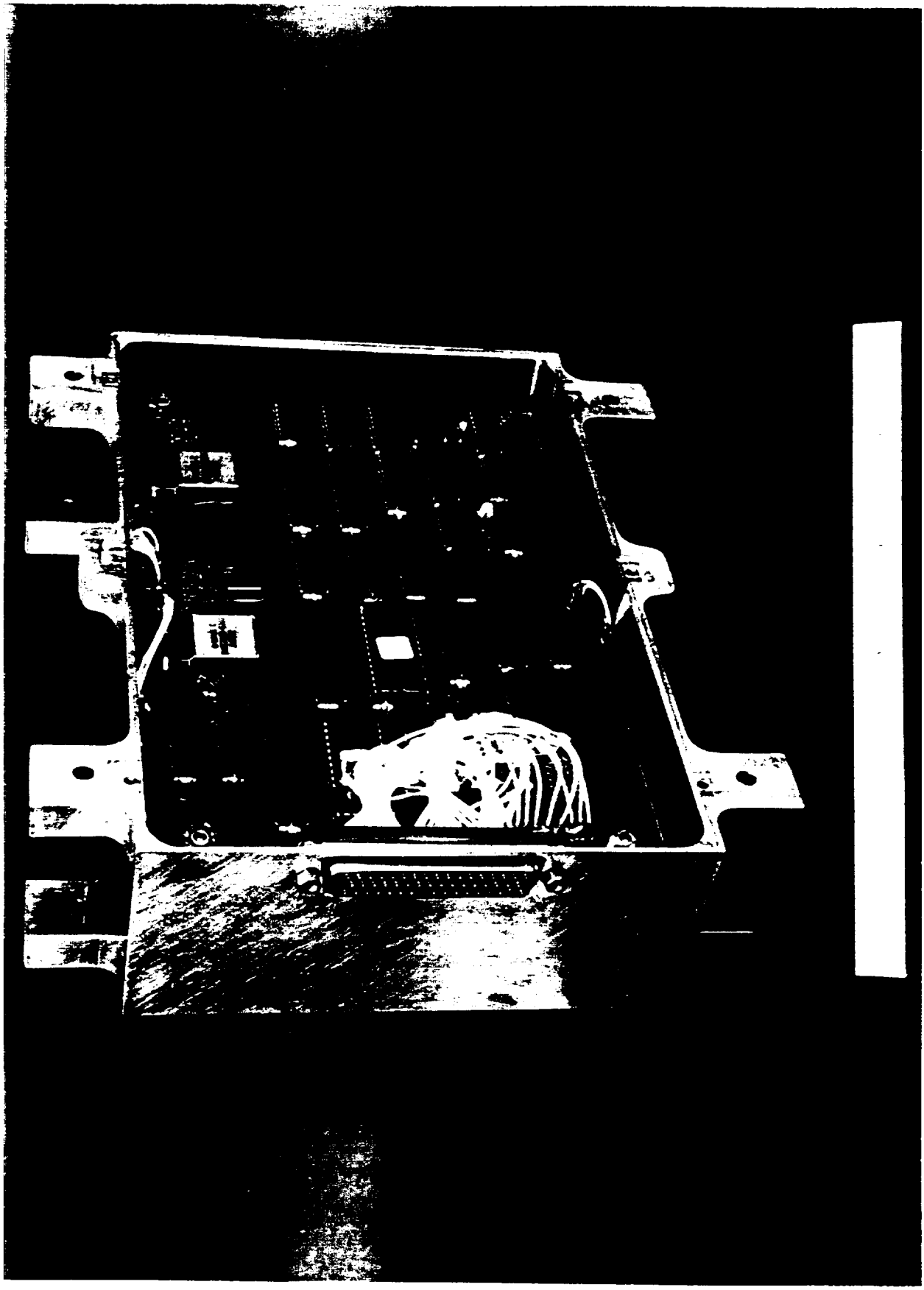


Figure 6. Pulsaur AREA
Correlator Electronics

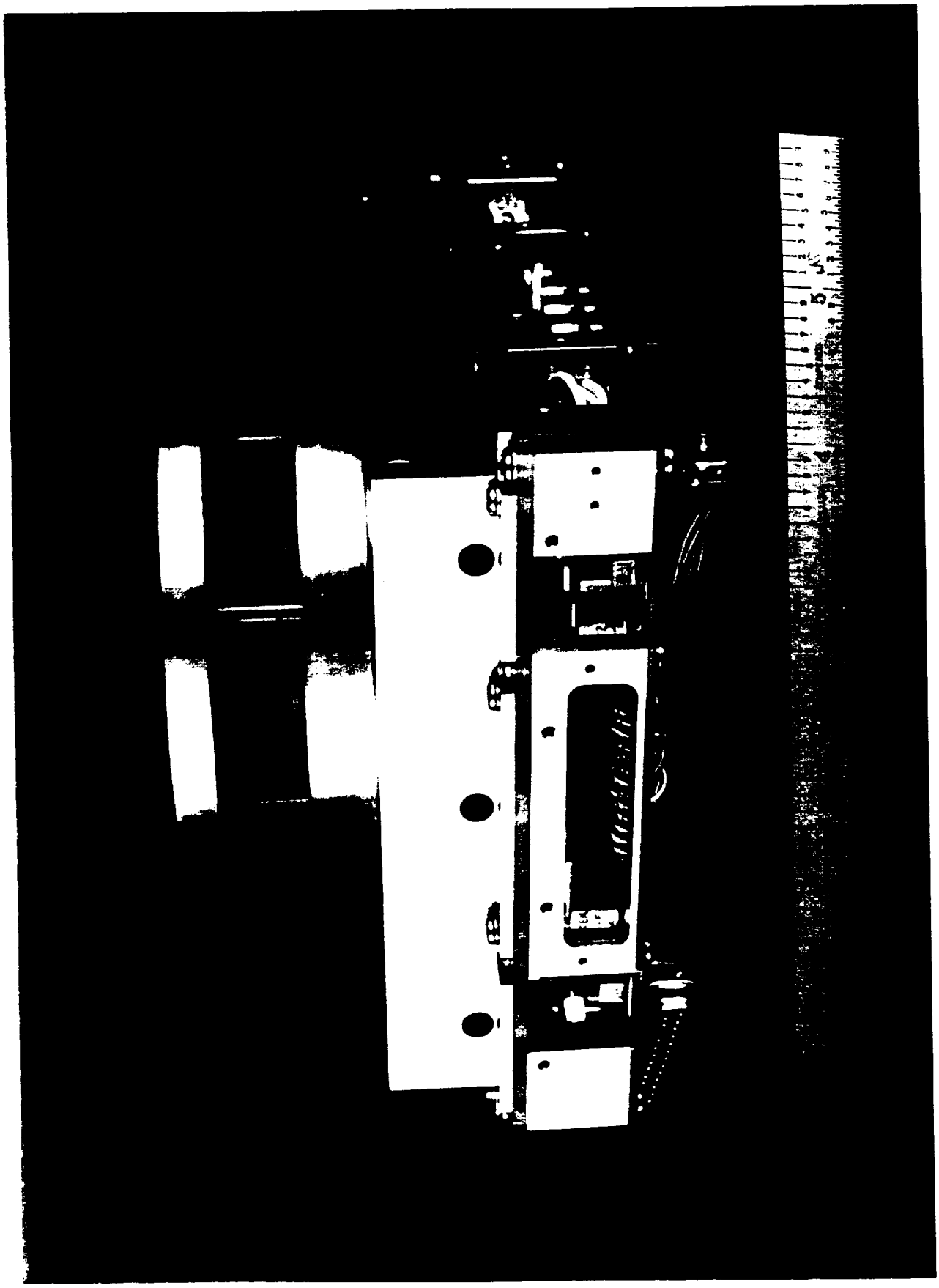


Figure 7. Pulsaur AREA Sensor

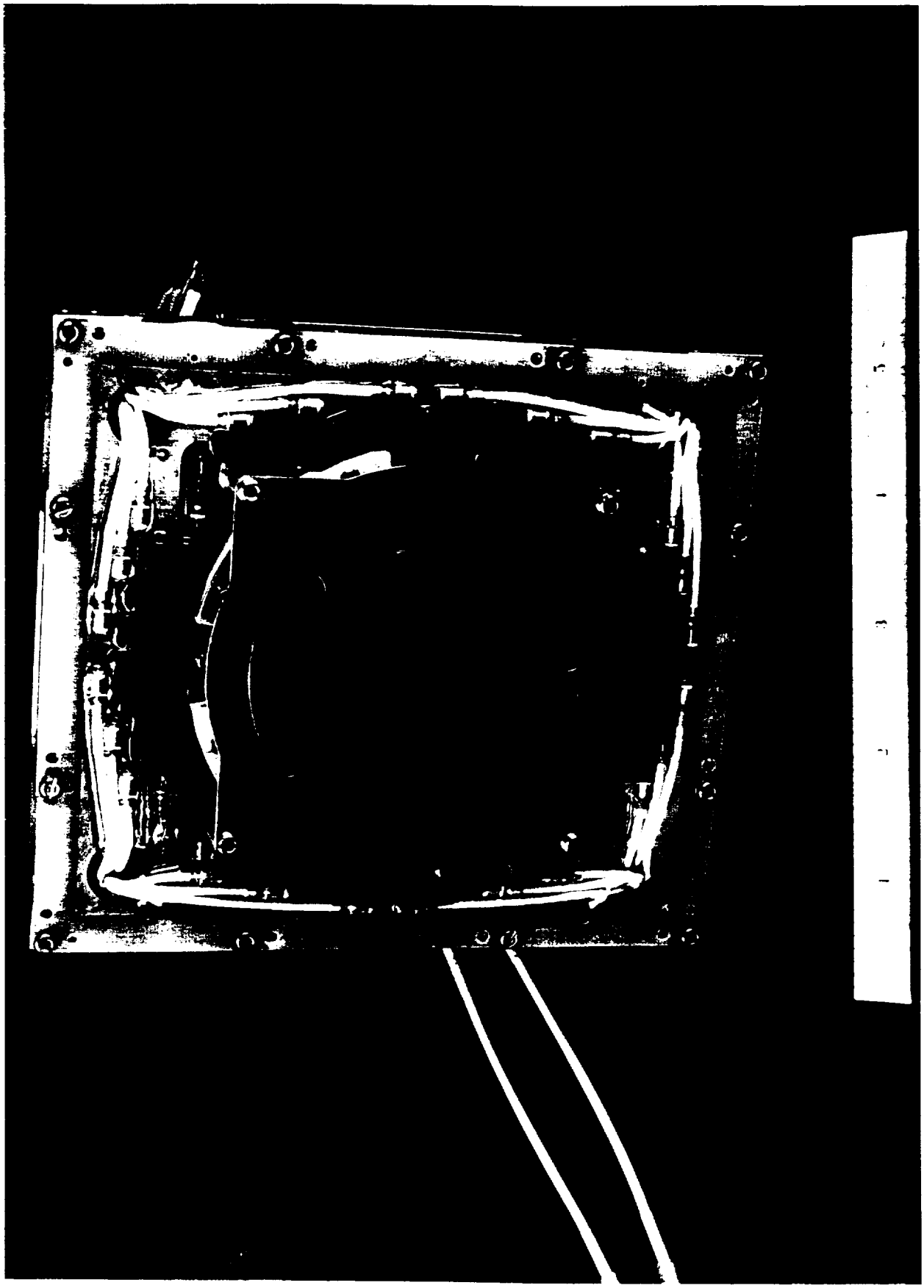
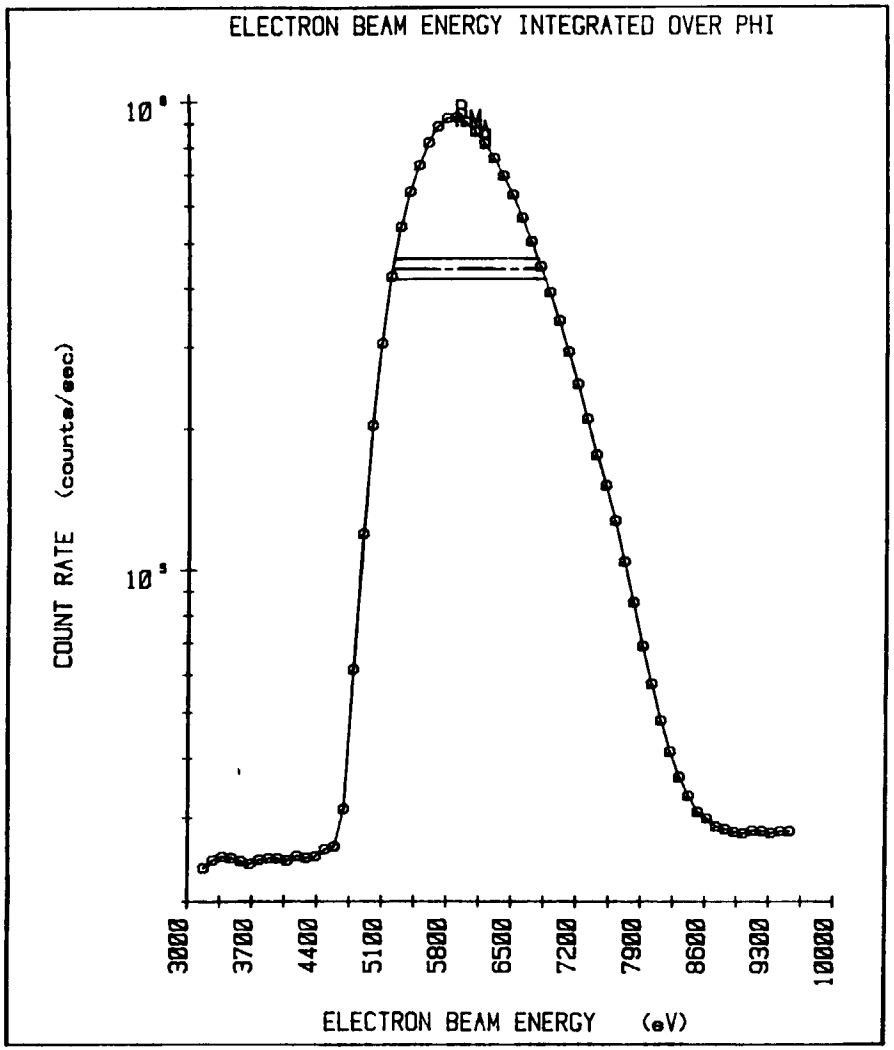


Figure 8. Pulsaur AREA Sensor w/Outer Deflection Plate Removed

ELECTRON BEAM ENERGY INTEGRATION



INSTRUMENT: 1-23

Voltage = 1000.000

Plot # 1765.000
Date Recorded: 93210
Date Processed: 03-AUG-93
Theta = 0.000

Only graph data points used for these calculations:
data integral: 1530546805.120

Arithmetic mean calculations
CR: 837270.055 CR/2: 418635.027
ELECTRON BEAM ENERGY : 6151.453 FWHM: 1667.953
ELECTRON BEAM ENERGY 1: 5186.288 ELECTRON BEAM ENERGY u: 6854.242
Sensitivity: 6.151 Resolution: 0.271

Median calculations
CR: 880288.376 CR/2: 440144.188
ELECTRON BEAM ENERGY : 6056.781 FWHM: 1609.993
ELECTRON BEAM ENERGY 1: 5204.190 ELECTRON BEAM ENERGY u: 6814.183
Sensitivity: 6.057 Resolution: 0.266

Most probable value calculations
CR: 927314.000 CR/2: 463657.000
ELECTRON BEAM ENERGY : 5896.430 FWHM: 1548.234
ELECTRON BEAM ENERGY 1: 5223.879 ELECTRON BEAM ENERGY u: 6772.113
Sensitivity: 5.896 Resolution: 0.263

All data points used for these calculations:
data integral: 1598841321.080

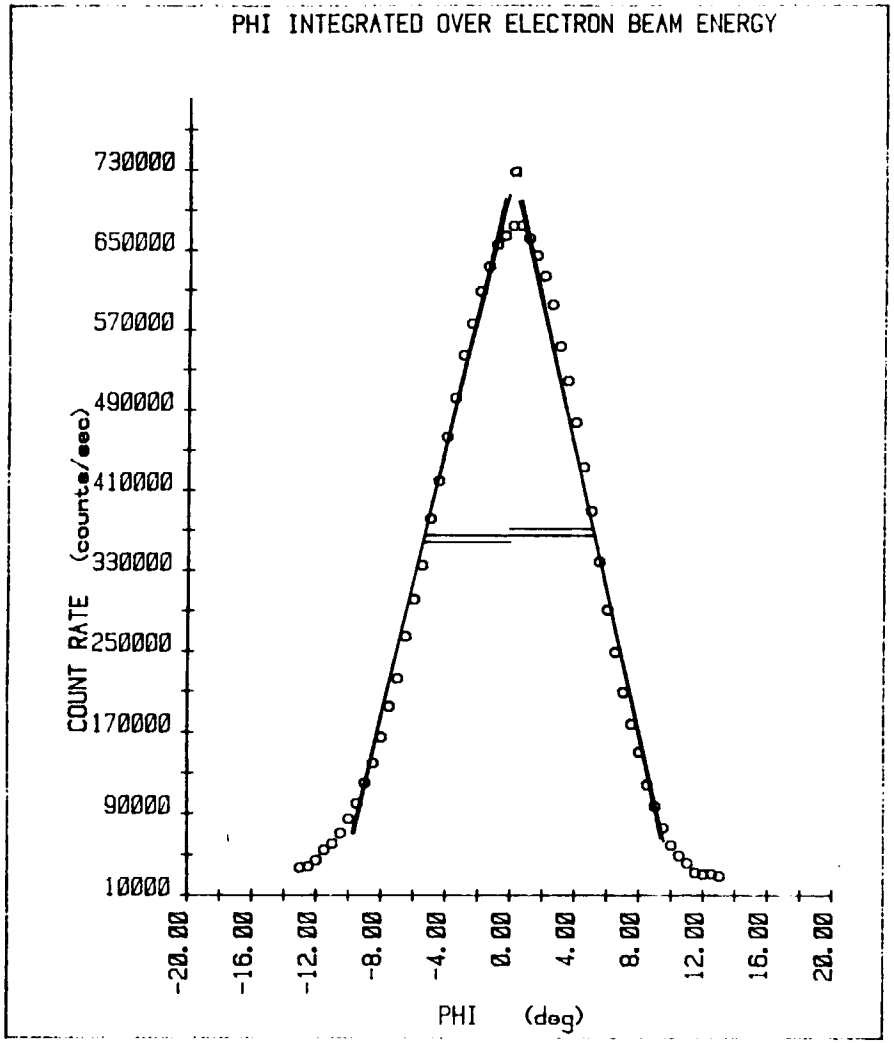
Arithmetic mean calculations
CR: 837608.699 CR/2: 418804.349
ELECTRON BEAM ENERGY : 6150.749 FWHM: 1667.491
ELECTRON BEAM ENERGY 1: 5186.430 ELECTRON BEAM ENERGY u: 6853.921
Sensitivity: 6.151 Resolution: 0.271

Median calculations
CR: 881882.208 CR/2: 440941.104
ELECTRON BEAM ENERGY : 6052.980 FWHM: 1607.874
ELECTRON BEAM ENERGY 1: 5204.854 ELECTRON BEAM ENERGY u: 6812.728
Sensitivity: 6.053 Resolution: 0.266

Most probable value calculations
CR: 927314.000 CR/2: 463657.000
ELECTRON BEAM ENERGY : 5896.430 FWHM: 1548.236
ELECTRON BEAM ENERGY 1: 5223.877 ELECTRON BEAM ENERGY u: 6772.113
Sensitivity: 5.896 Resolution: 0.263

Figure 9. Energy Response and Deflection Sensitivity Measurements -- Anode 23

PHI INTEGRATION



INSTRUMENT: 1-23

Voltage = 1000.00

Plot # 1766.00
Date Recorded: 93210
Date Processed: 03-AUG-93
Theta = 0.00

Only graph data points used for these calculations:

Single least squares line calculations
Y = (-68996.60)X + (725649.54) Coeff. of determination: 0.99
Data integral: 7627452.19 Line integral: 5797620.38
FWHM: 10.58 PHI peak: -0.06 CR: 729827.07
PHI l: -5.35 PHI u: 5.23 CR/2: 364913.54
Arithmetic mean: -0.15

Split least squares calculations
left line calculations:
Y = (66499.50)X + (720395.83) Coeff. of determination: 0.99
Data integral: 3501574.40 Line integral: 3029629.02
HWHM: -5.39 PHI peak: -0.06 CR: 716369.49
PHI l: -5.45 PHI u: -0.06 CR/2: 358184.75
right line calculations:
Y = (-71897.92)X + (739299.31) Coeff. of determination: 0.98
Data integral: 3791526.30 Line integral: 2803341.67
HWHM: 5.17 PHI peak: -0.06 CR: 743652.51
PHI l: -0.06 PHI u: 5.11 CR/2: 371826.25

Figure 10. Angular Response in Phi -- Anode 23